

Appl. No. 10/063,880
Amdt. dated February 3, 2005
Reply to Office action of November 16, 2004

REMARKS/ARGUMENTS

In response to the Office action identified above, please accept the following remarks.

5 **1. Objection to claims 17 and 37:**

Claim 17 recites the limitation "a second corner region" in line 17. There is insufficient antecedent basis for this limitation in the claim.

10 Claim 37, line 2, replace "a plurality of first solder pads" with --the plurality of first solder pads--.

Appropriate correction is required.

Response:

15 The applicant apologizes for incorrectly typing the limitation "a second predetermined region" as "a second corner region" in claim 17 listed in the previous response filed on Sep. 30, 2004. However, the applicant merges claim 29 into claim 17 to amend the limitation "a second predetermined region" as "a second corner region" in the current response.
20 As a result, the limitation "a second corner region" is still remained in the currently amended claim 17. Allowance of the amended claim 17 is politely requested.

25 Claim 37 is canceled as indicated in the above "Amendments to the Claims" section, and consideration thereto is no longer needed.

2. Rejection of claims 36-37 under 35 U.S.C. 112:

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Claims 36-37 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

- 5 ● Regarding claim 36, the limitations "a plurality of second solder pads arranged in a ring" and "the second solder pads being positioned only at corners of the substrate" render the claim indefinite.

It is not clear how the second solder pads arranged in the ring and at the same time positioned only at corners of the substrate.

- 10 The specifications and the drawings disclose that the second solder pads arranged in a ring (fig. 10) and, in another embodiment, the second solder pads positioned only at corners of the substrate (fig. 11).

Response:

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Claims 36-37 are canceled as indicated in the above "Amendments to the Claims" section, and consideration thereto is no longer needed.

3. Rejection of claims 1, 5, 7 and 35 under 35 U.S.C. 102(e):

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Claims 1, 5, 7 and 35 are rejected under 35 U.S.C. 102(e) as being anticipated by Potter et al. (U.S. Pat. 6,444,563) [newly cited].

- 25 Potter et al. (figs. 3-7, column 3, lines 5 et seq.) disclose solder pads for improving reliability of a package, the package comprising a substrate 20 or 26 (fig.3, column 3, lines 11-15) the solder pads with two sizes of diameters comprising:

a plurality of first solder pads 12 positioned on a surface of the substrate to occupy the entire surface of the substrate except the corners, each of the first solder pads having a first diameter; and

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at least a second solder pad 22 positioned on a corner region of the substrate surface, the second solder pad having a second diameter greater than the first diameter to sustain a stronger thermal stress and a stronger fatigue strength (column 5, lines 5-8).

- Regarding claim 5, Potter et al. disclose that the substrate 20 comprises a chip (figs. 3-7, column 3, line 4).
- Regarding claim 7, Potter et al. disclose that portions of the first solder pads are arranged in a rectangular array at a center region of the substrate (fig. 3).
- Regarding claim 35, Potter et al. disclose that the first solder pads are arranged out of the rectangular array and adjacent to the second solder pad on the corner region (fig. 3).

Response:

Claim 1 is amended to overcome this rejection. The amended claim 1 limited the first solder pads to being arranged in a first circle within the scope of the substrate, and limited the second solder pads to being arranged out of the first circle. The amended claim 1 is fully supported by the disclosure, and specifically, by Figs. 10 and 11, for instance. No new matter is introduced.

An advantage of arranging the first solder pads in the first circle is to provide a uniform distribution of the thermal and mechanical stresses among the first solder pads of the package, preventing deformation of the package due to the stresses. For example, each of the first solder pads arranged in the first circle is supposed to sustain the same stress as the others in the same circle while changing the ambient temperature.

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As shown in Fig. 1 of Potter et al.'s disclosure, the first solder pads 12 are arranged in rectangles at the center and the edge of the substrate 10. Potter et al. teach to replace the smaller solder pads 12 at the corners of the outer rectangle with the bigger solder pads 22 (Fig. 3). If the corners of the outer rectangle are high-stress regions, the corners of the inner rectangle should sustain higher stress than the other locations in the same rectangle. It is therefore believed that the stress distribution among the first solder pads arranged in a rectangle is different from the stress distribution among the first solder pads arranged in a circle. Since both the arrangement of the first solder pads and the stress distribution among the first solder pads taught by Potter et al. are different from the first solder pads of the present application, the applicant believes that the amended claim 1 of the present application is absolutely different from Potter et al.'s disclosure. Reconsideration of the amended claim 1 is politely requested.

Claim 7 is amended to introduce the limitation of arranging portions of the first solder pads in a plurality of circles at a center region of the substrate and within the first circle. The amended claim 7 is supported by Figs. 10 and 11. As claims 5 and 7 are dependent upon the amended claim 1, they should be allowed if the amended claim 1 is allowed. Reconsideration of claims 5 and 7 is therefore requested.

Claim 35 is canceled as indicated in the above "Amendments to the Claims" section, and consideration thereto is no longer needed.

4. Rejection of claims 2-4 and 13 under 35 U.S.C. 103(a):

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Claims 2-4 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Potter et al. (U.S. Pat. 6,444,563) [newly cited] in view of Guzik et al. (U.S. Pat. 5,153,379) [previously applied].

5 Potter et al. disclose the claimed invention except for not specifically point out that the substrate comprises a plastic substrate or a ceramic substrate.

10 However, Guzik et al. disclose a semiconductor device comprising a substrate and wherein the substrate is preferably a ceramic board, an insulating material such as glass epoxy board or a printed circuit board (column 2, lines 39-45). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to replace the substrate of Potter et al. by a ceramic board, a glass epoxy board or a PCB, as taught by Guzik et al., in order to increase the heat
15 dissipating characteristics.

- Regarding claim 13, Guzik et al. disclose the corner region comprises at least a grounded solder pad (column 1, lines 66-67 and column 2, lines 5-6).

20 **Response:**

Claim 13 corrects some grammatical problems to correspond with the amended claim 1. No new matter is introduced in the amended claim 13. As claims 2-4 and 13 are dependent upon the amended claim 1, they
25 should be allowed if the amended claim 1 is allowed. Reconsideration of claims 2-4 and 13 is therefore requested.

5. Rejection of claims 9-12 under 35 U.S.C. 103(a):

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Claims 9-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Potter et al. (U.S. Pat. 6,444,563) [newly cited] in view of Applicant Admitted Prior Art (figs. 1 and 4).

- 5 ● Regarding claim 9, Potter et al. disclose the claimed invention except for not specifically point out that the corner region comprises the circumferences of a plurality of concentric circles on the substrate.

However, AAPA (fig. 4) disclose a plurality of first solder pads 14 and a plurality of second solder pads 24, the plurality of second solder
10 pads 24 positioned on a corner region; wherein the corner region comprises the circumferences of a plurality of concentric circles on the substrate. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the substrate of Potter et al. by having the circumferences of a plurality of concentric
15 circles at the corner region, as taught by AAPA (figs. 1 and 4), to prevent the package not crack easily at the corner of the chip.

- Regarding claim 10, AAPA discloses the second solder pads on each of the concentric circle circumferences are arranged with an equal interval (fig. 4).
- 20 ● Regarding claim 11, AAPA discloses the corner region comprises the corners of the substrate on an outside portion of a maximum circle on the substrate (fig. 4).
- Regarding claim 12, AAPA discloses the corner region comprises the circumference of a maximum circle on the substrate (fig. 4).

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Response:

Claims 9, 11, and 12 are amended according to Figs. 10 and 11 to correspond with the amended claim 1. The amended claim 9 limited the

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second solder pads to being arranged in a plurality of concentric circles (Fig. 11). The amended claim 11 limited the first circle consisted of the first solder pads to being the maximum circle within the scope of the substrate (Fig. 11). The amended claim 12 limited the second circle consisted of the second solder pads to being the maximum circle within the scope of the substrate (Fig. 10). As shown in Fig. 4, however, AAPA does not illustrate to arrange the first solder pads in a first circle within the scope of the substrate, nor teach any second solder pads positioned out of the first circle consisted of the first solder pads. Since Potter et al. do not even suggest to arrange the first or second solder pads in a circle, the applicant respectfully believes that one of ordinary skill cannot combine Potter et al.'s invention with AAPA to accomplish the present application. Reconsideration of claims 9-12 is politely requested.

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6. Rejection of claims 14-16 under 35 U.S.C. 103(a):

Claims 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Potter et al. (U.S. Pat. 6,444,563) [newly cited] in view of Taniguchi et al. (U.S. Pat. 6,404,062) [newly cited].

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- Regarding claims 14-15, Potter et al. fail to disclose a solder bump, a chip and an underfill layer.

However, Taniguchi et al. (figs. 4-5, column 2, lines 21 et seq.) disclose a semiconductor device comprising:

25

a substrate 23; the first solder pads and the second solder pad comprise a solder bump pad 16, the solder bump pad connecting to a solder bump 14 and using the solder bump to connect to a chip 11; an underfill layer 18 in a gap between the chip 11 and the substrate 23. Therefore, it would have been obvious to one having ordinary skill in

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the art at the time the invention was made to modify the device of Potter et al. by having the solder bump, the solder pad and the underfill layer, as taught by Taniguchi et al., in order to form a multiple housing package and to reduce mismatch of a coefficient of thermal expansion of the die with the substrate.

● Regarding claim 16, Taniguchi et al. disclose that the first and second solder pads comprise a solder ball pad 21, the solder ball pad connecting to a solder ball 13 and using the solder ball to connect to a printed circuit board 19 (fig. 5).

Response:

Claims 14 and 16 correct some grammatical problems to correspond with the amended claim 1. No new matter is introduced in the amended claims 14 and 16. As claims 14-16 are dependent upon the amended claim 1, they should be allowed if the amended claim 1 is allowed. Reconsideration of claims 14-16 is therefore requested.

7. Rejection of claims 17, 20-22 and 28-29 under 35 U.S.C. 103(a):

Claims 17, 20-22 and 28-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Pu et al. (U.S. Pat. 6350669) [previously applied] in view of Ishii (JP. 2001-257289) [previously applied].

Pu et al. discloses a semiconductor device (cover fig.) comprising:
a substrate 310;

a plurality of first solder bump pads A2 positioned on a first surface of the substrate, each of the first solder bump pads having a first diameter

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and

at least a second solder bump pad A1 positioned on a first predetermined region of the first substrate, the second solder bump pad
5 having a second diameter greater than the first diameter (column 4, lines 52-54), each of the first solder bump pads and the second solder bump pad being connected to a solder bump 321 that is connected to a chip 300.

Pu et al. fail to disclose a plurality of first solder ball pads positioned on a second surface of the substrate, each of the first solder ball pads
10 having a third diameter, and at least a second solder ball pad positioned on a second predetermined region of the second surface, the second solder ball pad having a second diameter greater than the third diameter.

However, Ishii discloses a semiconductor device (figs. 7a-b) comprising:

15 a plurality of first solder ball pads 2d positioned on a second surface of the substrate 1, each of the first solder ball pads having a third diameter; and

at least a second solder ball 2a positioned on a second predetermined region of the second surface, the second solder ball pad having a fourth
20 diameter greater than the third diameter, each of the first solder ball pads and the second solder ball pad being connected to a solder ball 3 that is connected to a circuit board 7 (figs. 9a-b). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Pu et al. by having the diameter of the
25 second solder ball pad greater than the diameter of the first solder ball pad, as taught by Ishii, to provide a high reliability for the semiconductor package device and relax the influence of distortion caused by difference in thermal expansion between the package and the mounting board.

● Regarding claim 20, since Pu et al. and Ishii disclose all claimed

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structural features. Therefore, the package inherently comprises a high stress region at the first predetermined region and the second predetermined region.

- Regarding claims 21 and 28, Ishii discloses the small diameter pads are arranged in a matrix at a center region of the substrate (figs. 7a-7b).
- Regarding claims 22 and 29, Ishii discloses the predetermined region comprises the corners on the surface of the substrate (figs. 7a-7b).

10 **Response:**

Claim 17 is amended by merging claims 22 and 29 and by introducing the features shown in Figs. 5-7. The amended claim 17 is repeated below:

- 15 Claim 17 (currently amended): Solder pads with two sizes of diameters comprising:

a substrate;

- 20 a plurality of first solder bump pads positioned on a first surface of the substrate to occupy the entire first surface of the substrate except the corners, portions of the first solder bump pads being arranged in a first rectangular array at a center region of the first surface, and portions of the first solder bump pads being arranged out of the first rectangular array, each of the first solder bump pads having a first diameter;

- 25 at least a second solder bump pad positioned on a first predetermined corner region of the first surface, the second solder bump pad having a second diameter greater than the first diameter, each of the first solder bump pads and the second solder bump pad being connected to a solder bump that is connected to a chip;

a plurality of first solder ball pads positioned on a second surface of

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the substrate to occupy the entire second surface of the substrate except
the corners, portions of the first solder ball pads being arranged in a
second rectangular array at a center region of the second surface, and
5 portions of the first solder ball pads being arranged out of the second
rectangular array, each of the first solder ball pads having a third diameter;
and

at least a second solder ball pad positioned on a second ~~corner~~ corner
region of the second surface, the second solder ball pad having a fourth
10 diameter greater than the third diameter, each of the first solder ball pads
and the second solder ball pad being connected to a solder ball that is
connected to a printed circuit board.

As disclosed in the amended claim 17, the smaller first solder bump
15 pads are positioned on the entire first substrate surface except the corners,
and the bigger second solder bump pad is positioned at the corner of the
first substrate surface. In addition, the smaller first solder ball pads are
positioned on the entire second substrate surface except the corners, and
the bigger second solder ball pad is positioned at the corner of the second
20 substrate surface. The present application positions the bigger solder
bump pad or the bigger solder ball pad only at the corners (the high stress
region) of the substrate surface to sustain a stronger thermal stress and a
stronger fatigue strength, and positions the smaller solder bump pads or
the smaller ball pads on the entire substrate except the corners to increase
25 the bonding circuit density of the package as well.

Pu et al. do not show the features of the amended claim 17, such as
positioning the bigger solder bump/ball pads only at the corners of the
substrate surface and positioning the smaller solder bump/ball pads on the

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entire substrate except the corners. Furthermore, as shown in Fig. 3C of Pu et al.'s disclosure, the BGA package 300 has a plurality of bond pads 301 with the same sizes, and the circuit board 310 has a plurality of bond pads 311 with the same sizes. Pu et al. disclose that the *pad joint area A1* of the first group of solder balls 321 would be greater than the *pad joint area A2* of the second group of solder balls 322 (Col. 4, lines 52-54), however, Pu et al. never disclose the *bond pads 301 or 311* have different diameters. The pad joint area A1, A2 taught by Pu et al. cannot be read as the pad area of the present application. The pad joint area A1 taught by Pu et al. refers to the joint area between the solder ball 321 and the solder pad 311, and the pad joint area A2 refers to the joint area between the solder ball 322 and the solder pad 311. Pu et al. use materials of different melting point to form the solder ball 321 and the solder ball 322 (Col. 4, lines 24-26), so as to produce different joint areas A1 and A2 (Figs. 3B-3C, Col. 4, lines 27-55). Since Pu et al. never disclose solder pads with two sizes of diameters, nor position the bigger solder bump/ball pads only at the corners of the substrate surface and position the smaller solder bump/ball pads on the entire substrate except the corners, as are disclosed in the amended claim 17 of the present application, the applicant believes the amended claim 17 of the present application is absolutely different from Pu et al.'s disclosure.

Referring to Figs. 7a and 7b of Ishii's disclosure, the smaller first solder pads 2d are positioned at a small area of the substrate surface, instead of being positioned on the entire substrate except the corners. Ishii merely positions the smaller solder pads 2d at the center of the substrate surface to form bigger solder bumps 3d within the small area of the substrate. Ishii never specifically teaches to enlarge the solder pads at the

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corner and keeps all the other solder pads in small sizes so as to strengthen the package structure and keep high bonding circuit density, as are disclosed in the present application.

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The applicant also intends to point out the difference between the disclosure of Potter et al. (U.S. Pat. 6,444,563) and the present invention. Potter et al. disclose to position the smaller solder pads 12 in a "rectangle", instead of in a "rectangular array" at the center of the device 20 (Fig. 3). Although Potter et al. do teach that "the metal pads are generally any number of conductive contact regions that are exposed at a top surface of the device 20 in order to enable electrical contact to electrical circuitry formed on the device 20" (Col. 3, lines 4-8), they do not specifically suggest to position the smaller solder pads on the entire substrate surface except the corners and arrange portions of the smaller solder pads in a rectangular array at the center of the substrate. In fact, Potter et al. even suggest that, "locate the larger metal pads 22 at the package corners or at or near the center of the ball grid array" (Col. 3, lines 36-37). Therefore, the arrangement of the solder pads taught by Potter et al. is different from the amended claim 17.

From the aforementioned reasons, the applicant believes that the amended claim 17 of the present application is absolutely different from the cited references. Since none of Pu et al., Ishii, and Potter et al. teach to position the smaller solder pads on the entire substrate surface except the corners and arrange portions of the smaller solder pads in a rectangular array at the center of the substrate solder pads, the applicant respectfully believes that one of ordinary skill cannot combine the cited references to accomplish the present application. Reconsideration of the

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amended claim 17 is politely requested.

Claims 22 and 29 are merged in to the amended claim 17 and therefore
5 canceled. Claims 20, 21, and 28 are amended and supported by Figs. 5-7.
No new matter is introduced. As claims 20, 21, and 28 are dependent upon
the amended claim 17, they should be allowed if the amended claim 17 is
allowed. Reconsideration of claims 20, 21, and 28 is therefore requested.

10 **8. Rejection of claims 18-19, 23-26 and 30-33 under 35 U.S.C. 103(a):**

Claims 18-19, 23-26 and 30-33 are rejected under 35 U.S.C. 103(a) as
being unpatentable over Pu et al. (U.S. Pat. 6350669) [previously applied]
in view of Ishii (JP 2001-257289) [previously applied] and further in view
15 of AAPA (figs. 1 and 4).

● Regarding claims 23 and 30, as discussed in details above, the
combination of Pu et al. and Ishii disclose all the limitations as
claimed above except for not specifically point out that the
predetermined region comprises the circumferences of a plurality of
20 concentric circles on the substrate.

AAPA (figs. 1 and 4) disclose a plurality of first pads 14 and a
plurality of second pads 24, the plurality of second pads 24 positioned
on a predetermined region; wherein the predetermined region
comprises the circumferences of a plurality of concentric circles on
25 the substrate. Therefore, it would have been obvious to one having
ordinary skill in the art at the time the invention was made to modify
the above combination by having the circumferences of a plurality of
concentric circles at the corner region, as taught by AAPA (figs. 1 and
4), to prevent the package not crack easily at the corner of the chip.

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- Regarding claims 18-19, AAPA (fig. 1) discloses that a substrate 18 comprises a plastic substrate or a ceramic substrate.
- Regarding claims 24 and 31, AAPA discloses that the second pads on
5 each of the concentric circle circumferences are arranged with an equal interval (fig. 4).
- Regarding claims 25 and 32, AAPA discloses that the predetermined region comprises the corners of the substrate on an outside portion of a maximum circle on the substrate.
- 10 ● Regarding claims 26 and 33, AAPA discloses that the predetermined region comprises the circumference of a maximum circle on the substrate (fig. 4).

Response:

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Claims 18-19 are dependent upon the amended claim 17, and they should be allowed if the amended claim 17 is allowed. Reconsideration of claims 18-19 is therefore requested.

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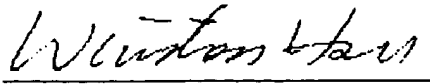
Claims 23-26 and 30-33 are canceled as indicated in the above "Amendments to the Claims" section, and consideration thereto is no longer needed.

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Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

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Sincerely yours,



Date: February 03, 2005

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